MODEL 4700

DIGITAL MULTIMETER

TRIPLETT®

A Penril COMPANY

INSTRUCTION MANUAL

MP MASTER

MA26105

INSTRUCTION MANUAL
MODEL 4700
4½ DIGITAL MULTIMETER

TRIPLETT®

A Penril COMPANY

Triplett Corporation
One Triplett Drive
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SAFETY RULES

Warning

This tester has been designed with your safety in mind. However, no design can completely protect against incorrect use. Electrical circuits can be dangerous and/or lethal when lack of caution or poor safety practices are used.

Read The Manual

Read this Instruction Manual carefully and completely. Voltages and currents within the capability of this test equipment can be hazardous. Follow the instructions in this manual for every measurement. Read and understand the general instructions before attempting to use this tester. Do not exceed the limits of the tester.

Safety Check

Double check the switch setting and lead connections before making measurements. Are you following all of the instructions? Disconnect the tester or turn off the power before changing the switch positions. Do not connect to circuits with voltages present when such switch is in any ohms or current position. When replacing fuses use only specified type fuses and insert in correct fuse holder.

Don't Touch

Don't touch exposed wiring, connections, or other "live" parts of an electrical circuit. If in doubt, check the circuit first for voltage before touching it. Turn off the power to a circuit before connecting test probes to it. Be sure there is no voltage present before you touch the circuit. Do not use cracked or broken test leads.

High Voltage Is Dangerous

Always start with the power off. Be sure there is no voltage present before making connections to the circuit. Don't touch the tester, its leads, or any other part of the circuit while it is on. Before disconnecting the tester, turn the circuit off and wait for the meter to return to "zero."

Distribution Circuits Pack A Punch

In high energy circuits such as distribution transformers and bus bars, dangerous arcs of explosive nature can occur if the circuit is shorted. If the tester is connected across a high energy circuit when set to a low resistance range, a current range, or any other low impedance range, the circuit is virtually shorted. Special equipment designed for use with these circuits is available. Contact a qualified person for assistance before attempting to make measurements on any high energy circuit.

Safety Is No Accident

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INTRODUCTION

This manual is designed to instruct the user on safe and accurate operation of the Triplett model 4700 digital multimeter (DMM).

The model 4700 is a portable microcomputer based 4½ digit DMM small enough for field use, but with enough features to make it desirable for lab use. In addition to the usual DMM measurements of voltage, current, and resistance, the model 4700 has audible continuity detection, a logic probe, voltage measurements displayable in dBm, and the ability to store an input signal as an offset or RELative value.

Each measurement function has autopolarity, overrange indication, protection from overloads, and quantized feedback A/D conversion yielding accurate, linear measurements. The ac ranges use true RMS measurement to directly measure complex ac signals that are not sine waves. Diodes can be tested with the CONTinuity function or the 2 kΩ, 200 kΩ, and 20 MΩ resistance ranges. In-circuit resistance measurements may be made on the remaining resistance ranges.

Measurements functions are selected with a single rotary switch for ease of operation. Pressing the SELect switch selects the different measurement modes as shown on the display annunciators. The result of each measurement is displayed on the liquid crystal display (LCD).

Its ease of operation, versatility, and accuracy make the Triplett model 4700 an ideal instrument for the hobbiest, production worker, technician or engineer.

SPECIFICATIONS

The specifications of the model 4700 are listed in Table 1.

Table 1 Model 4700 Specifications

DC Volts:

Range	Resolution	Accuracy
200 mV	10 μV	
2 V	100 μV	
20 V	1 mV	±(.04% of reading + 2 digits)
200 V	10 mV	
1000 V	100 mV	

Input Impedance:	10 MΩ in parallel with < 100 pF
Normal Mode Rejection Ratio:	≥55 dB at 60 Hz
Common Mode Rejection Ratio:	≥90 dB at 60 Hz
Common Mode Voltage:	500 V (dc or dc plus peak ac) max. when battery eliminator is used
Response time to rated accuracy:	1 s maximum
Maximum input:	1000 V dc or dc plus peak ac except on the 200 mV and 2 V ranges for 30 s

AC Volts (true RMS, ac coupled):

Effective range: 5% of range to full-scale 40Hz-10kHz
10% of range to full-scale 10kHz-20kHz

Range	Resolution	Accuracy: 5% of range to full-scale				
		40Hz	500Hz	1kHz	10kHz	20kHz
200 mV	10 μV	±(.5% of reading + 10 digits)				±(1% of reading + 20 digits)
2 V	100 μV					
20 V	1 mV					
200 V	10 mV					
750 V	100 mV	±(.5% of reading + 15 digits)	±(1% of reading + 15 digits)		not specified	

Input impedance: 10 MΩ in parallel with <100 pF

Crest factor range: Wave forms with a peak to RMS ratio of 1:1 to 3:1 at full-scale, increasing down range

Response time to rated accuracy: 3 s maximum

Maximum input: 750 Vac or 1000 V peak ac plus dc

DC Current:

Range	Resolution	Accuracy	Burden Voltage typical (V)
2 mA	100 mA		.2
20 mA	1 μA	±(.5% of reading + 2 digits)	.2
200 mA	10 μA		.27
2000 mA	100 μA	± (1% of reading + 2 digits)	.9
10 A*	1 mA	±(1.5% of reading + 2 digits)	.15

*Near full-scale the reading will drift to a stable value within the specified accuracy.

Response time to rated accuracy: 1 s maximum

Overload protection: 2A/600V fuse (for high energy sources) except on the 10A range

AC Current (true RMS, ac sensing):

Effective range: 5% of range to full-scale

Range	Resolution	Accuracy 5% of range to full-scale 40Hz 1kHz	10kHz 20kHz	Burden Voltage typical (V)
2 mA	100 mA	±(1% of reading ± 10 digits)	not specified	.2
20 mA	1 μA			.2
200 mA	10μA			.27
2000 mA	100 μA			.9
10A	1 mA	±1.5% + 10 digits		.15

Response time to rated accuracy: 3 s maximum

Crest factor range: Wave forms with a peak to RMS ratio of 1:1 to 3:1 at full-scale, increasing down range

Overload protection: 2A/600 V fuse (for high energy sources) except on the 10A range

Resistance:

Range	Resolution	Accuracy
200 Ω	.01 Ω	
2 kΩ	.1 Ω	
20 kΩ	1 Ω	±(.25% of reading + 2 digits)
200 kΩ	10 Ω	
2 MΩ	100 Ω	
20 MΩ	1 kΩ	±(.5% of reading + 2 digits)

Open circuit voltage: 8 V

Response time to rated accuracy: 2 s maximum on all ranges except 10 s maximum on the 20 MΩ range

Overload protection: 500 Vdc or 500 Vac with a 300,000 V-Hz product for 30 s.

Continuity:

Threshold: < 200 Ω nominally

Indication:	tone produced for 500 ms or until continuity is interrupted, whichever is shorter
Accuracy:	±(.25% of reading + 2 digits)
Tone response time:	50 μs
Response time to rated accuracy:	2 s maximum
Test current:	1 mA
Open circuit voltage:	8 V
Overload protection:	500 Vdc or 500 Vac with a 300,000 V-Hz product for 30 s.

LOGIC probe:

Threshold:	1.75 V nominally
Minimum pulse width detectable:	60 μs without the))) mode 95 μs with the))) mode
Indication:	V in > threshold display HI V in < threshold display LO with the))) mode a 50 ms tone is produced. If edges occur before the tone from the previous edge is finished the tone duration extends until 50 ms after the last edge detected.
Overload protection:	1000 Vdc or dc plus peak ac

RELative Mode (ac or dc voltage, ac or dc current and resistance):

All specifications are the same as voltage, current, or resistance with the following exceptions.

Conversion:	Display reading = input − stored offset
Accuracy:	Error does not exceed the sum of the errors of the two measurements

dB Mode (ac or dc voltage):

All specifications are the same as ac or dc voltage measurements with the following exceptions.

Conversion:	Display reading = $20 \log \frac{\text{Vin}}{.7746}$, that is, 0 dB equals 1 mW into 600 Ω.

AC Accuracy:

Range	dBm	Accuracy: 5% of scale to full-scale			
		40 Hz	1 kHz	10kHz	20 kHz
200 mV	−98 to −11.76	±.15 dBm		±.2 dBm	
2 V	−78 to 8.24				
20 V	−58 to 28.24				
200 V	−38 to 48.24				
750 V	−28 to 60.28	±.2 dBm		not specified	

DC Accuracy (5% of scale to full-scale):	±.02 dBm

Resolution:	.01 dB from 5% of scale to full-scale .1 dB from 1% of scale to 5% of scale 1 dB below 1% of scale

Environmental:

Operating temperature:	0 °C to 50 °C
Storage temperature:	−40 °C to 50 °C
Temperature coefficient:	≤.1 times the applicable accuracy specification per °C for 0 °C to 18 °C and 28 °C to 50 °C
Relative humidity:	≤80% noncondensing 0 °C to 35 °C ≤70% noncondensing 35 °C to 50 °C

General:

Common mode voltage:	500 Vdc or dc plus peak ac from any measuring terminal to power line ground (when connected to battery eliminator)

Display update rate:	3 readings / s except in the LOGIC probe function
Battery life:	100 hours typical
Size:	7¼" x 3⅞" x 2"
Weight:	19.5 oz.

OPERATION

This section details the operation, use, controls, and features of the model 4700. Even though you may have used a multimeter before it is suggested you take the time to read the following section in order to take full advantage of the features offered by the model 4700.

CONTROLS AND FEATURES

The controls and features of the model 4700 are shown in Figure 1 and described in Table 2.

Table 2 Controls and Features Description

#	Description
1	Battery eliminator jack.
2	4½ digit LCD (19999 maximum count) with decimal points, HI, LO, OVER, —, LO BAT, dB, REL, and))) annunciators.
3	Sound port for CONTinuity and LOGIC probe edge detect.
4	SELect switch used to select measurement modes: RELative, dB, and))) .
5	Range and function switch.
6	V Ω mA high input terminal.
7	COMmon or low input terminal for all measurements.
8	10 Ampere high input terminal.
9	Stand used to elevate the instrument or to hang the instrument.
10	ON/OFF switch.

11 Battery compartment cover on rear of instrument housing four AA batteries.

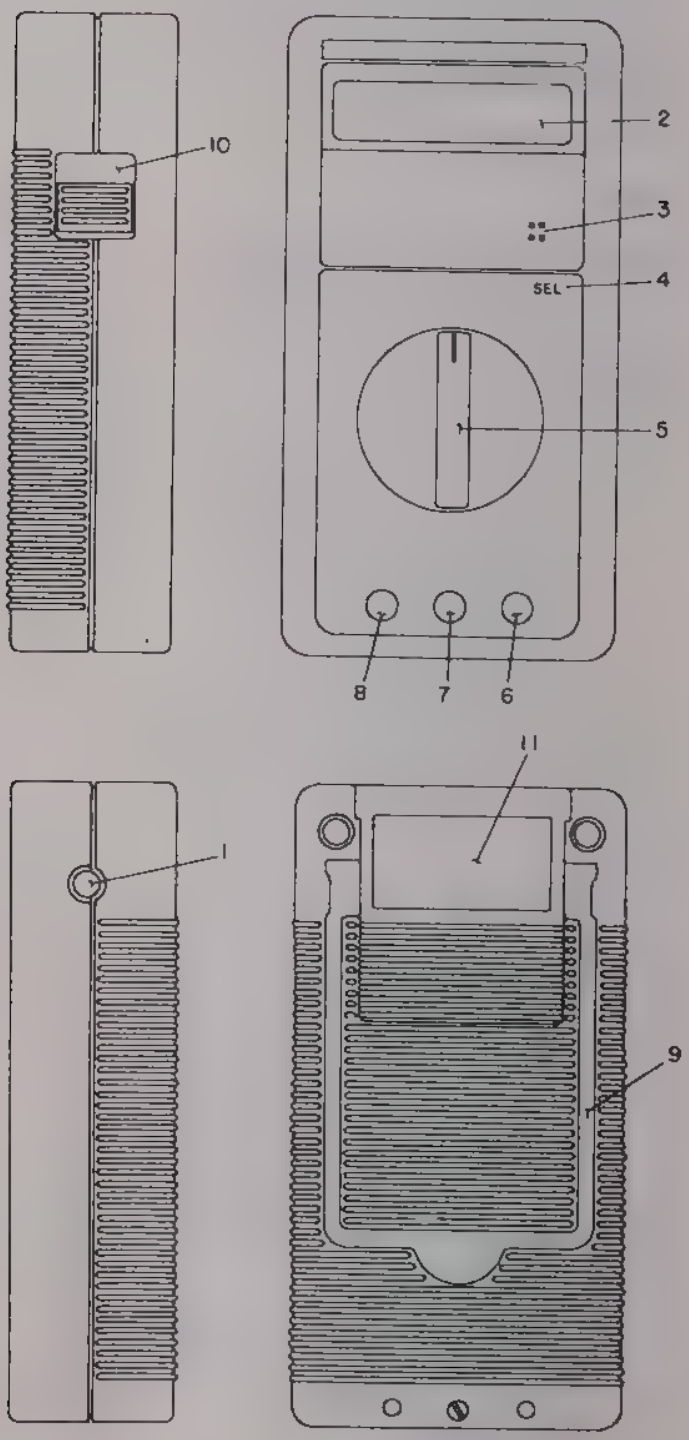


Figure 1 Controls and Features

Battery Installation and Replacement

The model 4700 operates on four AA batteries (type NEDA 15A). When you receive your model 4700 the batteries will not be installed. Use the following procedures to install or replace the batteries.

1. Turn off the unit.
2. Disconnect the test leads from any test points and remove the test leads from the input terminals.
3. Turn the unit over with the battery compartment to the top and away from you.
4. Place both thumbs near the bottom middle of the battery compartment cover and push down and forward as shown in Figure 2. The cover will snap open and slide free.
5. Install the batteries observing the proper polarity.
6. Slide and snap the battery compartment cover back into place.

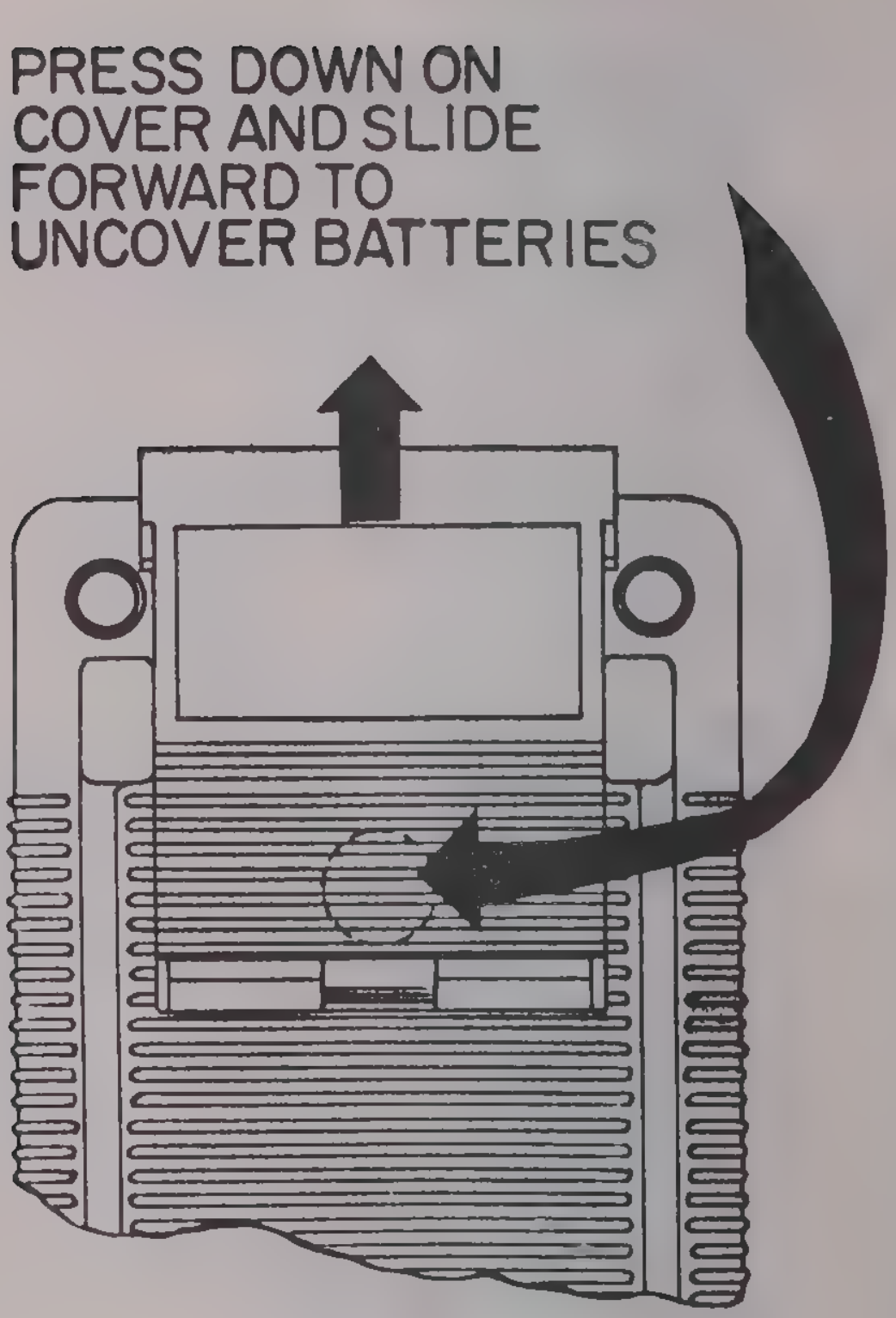


Figure 2 Battery Access

Liquid Crystal Display

The LCD is a high contrast 4½ digit display capable of displacing a count from 0-19999. For ease of discussion, a count of 19999 will be rounded to 20000. Instead of saying the 199.99 kΩ range we will say the 200 kΩ range. The decimal point is placed appropriately depending on the selected range. The LCD also contains eight annunciators:

HI — Used in the LOGIC probe, CONTinuity, and resistance functions. In the LOGIC probe function a HI represents a logic "1". In the CONTinuity and resistance functions a HI represents high power ohms, which will forward bias a pn junction.

LO — Used in the LOGIC probe, CONTinuity, and resistance functions. In the LOGIC probe function a LO represents a logic "0". In the resistance function a LO represents low power ohms, which will not forward bias a pn junction.

OVER — An overrange indicator for the 1000 Vdc range, 750 Vac range, 10 Adc range, and 10 Aac range. When this annunciator is on 5% or less of the range is left before the display indicates overrange.

— — The minus sign to indicate negative readings; a positive sign is implied.

LO BAT — The low battery indicator. When this annunciator is on approximately 5 hours of battery life are left.

dB — The displayed voltage measurement has been converted to dBm unless the REL annunciator is also on.

REL — The displayed measurement result has a stored offset subtracted from it. For example, if the RELative mode is selected while measuring 1.0000 Vdc the display will read .0000. If an input of 1.5000 Vdc is now applied the display will read .5000 (.5000 = 1.5000-1.0000).

))) — Used with the LOGIC probe and CONTinuity functions. In the LOGIC probe function if the))) mode is selected the tone will be produced at an edge. In the CONTinuity function the tone will be produced if the reading is less than 200 ohms, nominally.

Range and Function Switch

The range and function switch has 28 positions to select any of seven different measurement functions: ac volts, ac current, LOGIC probe, resistance, CONTinuitv, dc current, and dc volts. The diode symbol ( ) indicates which ranges will forward bias a pn junction. The musical note ( ) indicates which range will produce an audible tone.

Input Terminals

The input terminals are located below the range and function switch. They are marked 10 A, COM, V Ω mA. The COMmon is the low or negative input

for all measurement functions. Note the maximum voltage between COMmon and earth ground is 500 V. The V Ω mA input terminal is the high or positive input for all voltage, resistance, CONTinuity, current less than 2000 mA, and LOGIC probe function measurements. The input terminals are designed to accept shrouded safety banana plugs or common banana plugs. Shrouded banana plugs are recommended as a safety precaution.

SELect Switch

The SELect switch is used to change the measurement mode. Pressing the SELect switch will display the modes available in that function or display ERR0 if no modes are available. Depending on the measurement function one or more of the REL, dB, and))) annunciators will scroll on and off. To change the measurement mode press the SELect switch until the desired mode is displayed on the LCD.

Battery Eliminator

Located on the right side of the model 4700 is a jack for the battery eliminator. The model 4700 is capable of running off of batteries or the battery eliminator. Plugging the battery eliminator into the jack will disconnect the batteries and power the unit from the battery eliminator. When the battery eliminator plug is removed the batteries will be connected again.

Stand

The model 4700 is supplied with a dual purpose stand. The stand may be used to position the unit on a bench for ease of viewing. The stand may be removed and inserted into the other holes to aid in hanging the unit as shown in Figure 3.

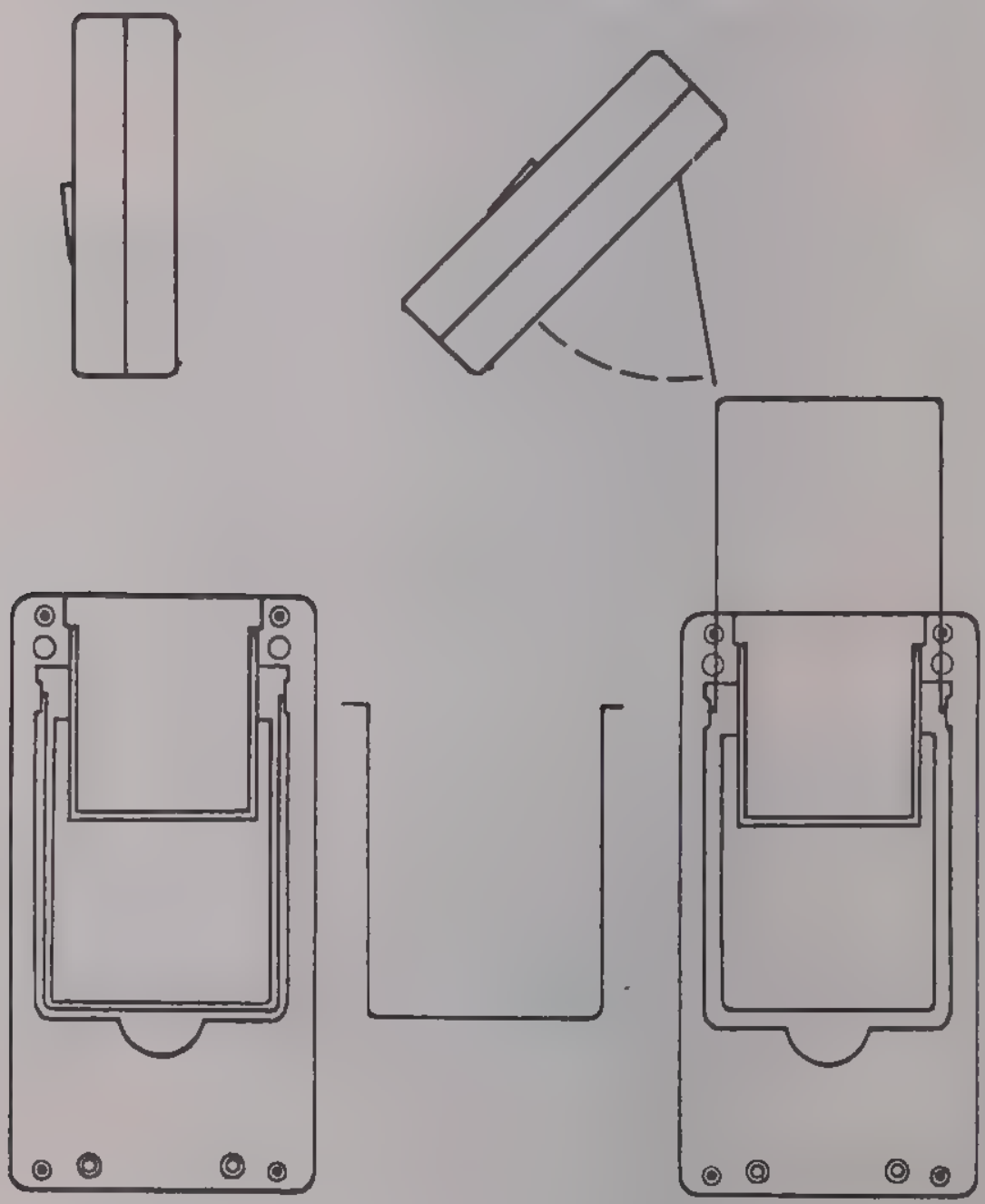


Figure 3 Dual Purpose Stand

OPERATING INSTRUCTIONS

Power-on Self-test

Whenever you turn on the model 4700, the instrument performs a self-test to make sure the display and the microcomputer are functioning properly. If everything is functioning properly all display segments and annunciators (except LO BAT) will turn on for about one second, after which the display will respond to the measurement selections. If the LCD segments do not all turn on or if ERR1 or ERR2 is displayed something is probably wrong with your instrument. The test may be run again by turning the unit off and back on. If the test fails repeatedly refer to the MAINTENANCE AND RECALIBRATION section of this manual for Basic Troubleshooting and or Service Information.

Safety Symbols

The front label shown in Figure 4 contains several safety symbols which advise the user of proper safety practices. They are explained below.

Be careful when making high voltage measurements. Do not touch test leads or input terminals.

Refer to instruction manual for explanation of operating instructions.

Do not connect the COMmon terminal to any source greater than 500 V referenced to earth ground.

The maximum recommended current through these terminals should not exceed 10 Aac or 10 Adc.

The maximum recommended voltage between these terminals is 1000 Vdc or 750 Vac. The maximum recommended current through these terminals is 2 Aac or 2 Adc.

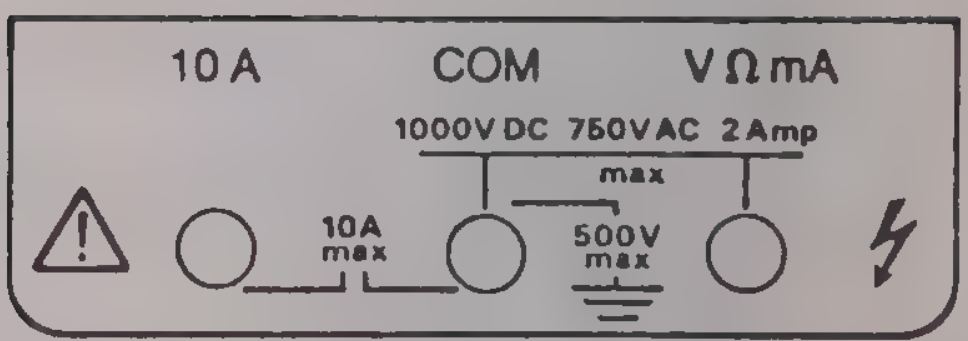


Figure 4 Front Label

Input Signal Limits

The model 4700 has certain input signal limits that must not be exceeded or you could damage the instrument, or more important hurt yourself and others around you. Table 3 lists the maximum inputs at the input terminals. The maximum voltage between the COMmon input terminal and earth ground is 500 V dc or dc plus peak ac.

Table 3 Input Overload Limits

Function	Input Terminals	Maximum Input
dc volts LOGIC probe	V Ω mA & COM	1000 Vdc or dc + peak ac
ac volts	V Ω mA & COM	750 Vac or 1000 V peak ac + dc
current ac or dc 2000 mA or less	V Ω mA & COM	2000 mA maximum, fuse protected to 600 V dc or ac RMS
current ac or dc 10 A	10 A & COM	10 A maximum dc or dc + ac
resistance CONTinuity	V Ω mA & COM	500 Vdc or 500 Vac with a 300,000 V-Hz product for 30 s

AC-RMS/DC Voltage

1. Select the desired ac or dc voltage range. If the voltage is unknown select the highest range.
2. Insert the test leads, black in the COMmon input terminal and red in the V Ω mA input terminal.
3. Observing all safety precautions connect the test leads across the voltage to be measured.

4. If the number displayed is less than 1999 a lower range can be selected to increase resolution.

AC-RMS/DC Current

1. Select the desired ac or dc current range. If the current is unknown select the highest range.
2. Insert the test leads, black in the COMmon input terminal and red in the V Ω mA input terminal if the current is less than 2000 mA. If the current is greater than 2000 mA, insert the red lead in the 10 A input terminal.
3. Observing all safety precautions, connect the test leads in series with the current to be measured.
4. If the number displayed is less than 1999 a lower current range can be selected to increase resolution. Turn the circuit under test off, select the next lower range, and re-energize the circuit under test. If the 10 A range was the starting point remember to move the red test lead to the V Ω mA input terminal with the circuit under test turned off.

Resistance

1. Select the desired resistance range noting that the 2 kΩ, 200 kΩ, and 20 MΩ ranges will forward bias a pn junction. If taking in-circuit measurements, the 200 Ω, 20 kΩ, and 2 MΩ ranges are preferred.

2. Insert the test leads, black in the COMmon input terminal and red in the V Ω mA input terminal.
3. If taking in-circuit measurements, make certain the circuit under test is not energized.
4. Place the test probes across the resistance to be measured.
5. If the minus sign remains on while taking an in-circuit resistance measurement, there may still be energy in the circuit under test. This will only happen if the voltage in the circuit under test is negative with respect to the COMmon input terminal. If the voltage is positive with respect to the COMmon input terminal the resistance reading will be erroneous.
6. If the number displayed is less than 1999 a lower resistance range can be selected to increase resolution.

CONTinuity

1. Select the CONTinuity function.
2. Insert the test leads, black in the COMmon input terminal and red in the V Ω mA input terminal.
3. If taking in-circuit measurements, the CONTinuity function will forward bias a pn junction.
4. Make certain that any in-circuit measurements are taken while the circuit under test is not energized or an erroneous measurement could result.

5. Connect the test probes to the points to be checked for continuity. If the resistance is less than 200 ohms, nominally, the tone will sound.

LOGIC Probe

1. Select the LOGIC probe function. If audible edge detection is desired press the SELect switch until the))) annunciator is displayed.
2. Insert the test leads, black in the COMmon input terminal and red in the V Ω mA input terminal.
3. Connect the black test lead to the logic circuit common and probe the points in question with the red test probe.
4. A voltage greater than 1.75 Vdc will indicate a logic "1". A voltage less than 1.75 Vdc will indicate a logic "0".

Measurement Modes

Depending on the measurement function selected different measurement modes may be available. In the voltage function the RELative mode and the dB mode are available. In the current and resistance function only the RELative mode is available. In the LOGIC probe function only the))) mode is available. In the CONTinuity function the))) mode is always enabled. The following three sections explain the use of the RELative mode, the dB mode, and the))) mode.

The RELative Mode

The RELative mode may be selected with measurements of ac or dc voltage, ac or dc voltage displayed as dB, ac or dc current, and resistance by pressing SELect. This mode stores a measurement result as an offset. The following measurement results will have the stored offset subtracted from the measurement by the microcomputer. For example, 1.0000 Vdc is stored by pressing SELect. The display will now read .0000. If the input is raised to 1.5000 Vdc, the display will read .5000 (.5000 = 1.5000 − 1.000). The stored measurement result may be canceled by pressing SELect until the REL annunciator turns off or by turning the instrument off.

The RELative mode remains in effect for range to range changes. The resolution of the stored offset is only as great as the resolution of the range it was established on. If a measurement result is stored and the next lower range is selected the least significant digit will be blanked. If a higher range is selected the least significant digit is truncated. For example, if .1234 Vdc is established as the RELative reference on the 2 Vdc range a 0 Vdc input on the 200 mV range will read −123.4X, where X is a blank digit. On the 20 Vdc range the reading would be −0.123.

When the measurement function is changed the RELative mode is canceled while in the other function. But, upon returning to the function where the RELative mode was established the offset is restored unless a new measurement mode was selected in the other function.

When using the RELative mode the display and the A/D convertor limit the input signal range. The LCD can only display 19999 counts and the A/D convertor can only convert 19999 counts. For example, 1.2000 V is stored using the RELative mode. The maximum positive display is .7999 V which is actually 1.9999 V input. The maximum negative display is −1.9999 which is only −.7999 V input. In this example, the positive signal input range is limited by the A/D convertor and the negative signal input range is limited by the display.

The dB Mode

The dB mode may be selected with measurements of ac or dc voltage by pressing SELect. This mode will convert the voltage to dBm, that is, 0 dB equals 1 mW into 600 ohms. For example, 1.0000 V will be displayed as 2.22 dB.

The dB mode remains in effect for range to range changes, but the resolution of the displayed measurement may change. This occurs because the resolution of decibel measurements is dependent upon the magnitude of the voltage being measured. For readings of 5% of full-scale or greater the displayed resolution is .01 dB. From 1% of full-scale to 5% of full-scale the displayed resolution is .1 dB. Below 1% of full-scale the displayed resolution falls to 1 dB. Anytime the resolution falls to .1 dB or 1 dB a lower range may be selected except on the 200 mV range which is the lowest ac or dc voltage range.

When the measurement function is changed the dB mode is canceled while in the other function. But, upon returning to the function where the dB mode was established the decibel display is restored unless a new measurement mode was selected in the other function.

The dB mode can be combined with the RELative mode to change the reference impedance. For example, dBV (1000 ohms reference impedance) measurements can be made by applying 1.0000 V and selecting the RELative mode in combination with the dB mode. More applications of this technique are given in the APPLICATION NOTES section of this manual.

The))) Mode

The))) mode is always enabled in the CONTinuity function. If continuity exists (200 ohms or less, nominally) the tone will be produced for 500 ms or until continuity is interrupted, whichever is shorter. In the LOGIC probe function audible edge detection may be enabled by pressing SELect. If the))) mode is used the LOGIC probe function will produce a 50 ms tone at an edge. If edges occur before the tone from the previous edge is finished the tone duration extends until 50 ms after the last edge detected. When the))) mode is used the LOGIC probe function cannot detect as narrow a pulse as when it is not used. This is due to the processing time required to turn the tone on and off.

APPLICATION NOTES

The following application notes are added to make your Triplett DMM even more useful. These notes by no means cover all the uses, but are designed to help you utilize your DMM to greater advantage.

Measurement Errors

Measurements of voltage or current sometimes produce erroneous results. Voltage errors result from circuit loading and current errors result from the burden voltage of the instrument. These errors are explained more fully below.

Circuit Loading Error

Voltage measurements will load any circuit under test if the impedance of the circuit is significant compared to the input impedance of the model 4700 (10 MΩ in parallel with < 100 pF). When the circuit impedance is 1 kΩ or less, the error in the measurement will be less than or equal to .01%. If circuit loading occurs, the percentage error can be calculated using the following formulas shown in Figure 5.

DC VOLTAGE MEASUREMENTS:

Loading error in % = 100 x Rs / (Rs + 10 M). Where: Rs = Source resistance in ohms

AC VOLTAGE MEASUREMENTS (vector algebra required):

First, determine the input impedance.

$$Zin = \frac{10^7}{\sqrt{1 + (2\pi fRC)^2}}$$

Where: Zin = input impedance
R = 10 M ohms
C = 100 pF
F = frequency in Hz

Then, determine the error.

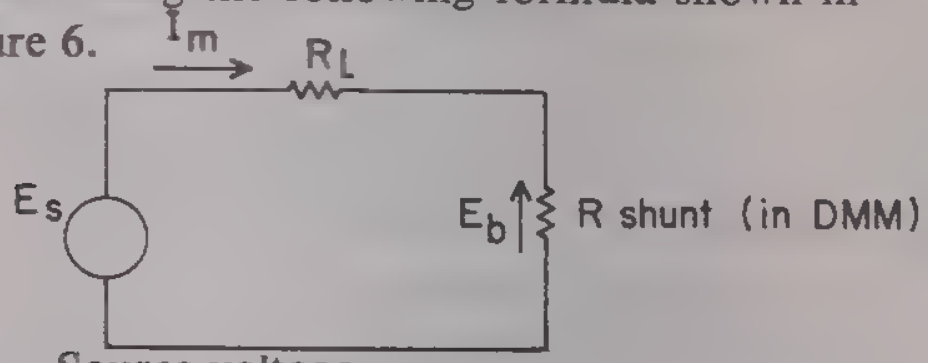
Loading Error in % = 100 x Zs / (Zs + Zin)

Where: Zs = source impedance
Zin = input impedance (calculated above)

Figure 5 Circuit Loading Error Calculations

Burden Voltage Error

When a meter is placed in series with a circuit under test to measure current, an error may be caused by the voltage drop across the meter. This voltage is referred to as the burden voltage and it is caused by the current shunt and fuse. The burden voltage may effect the accuracy of the measurement if the current source is unregulated or the shunt and fuse represents a significant part of the source resistance (i.e. 1/1000 or more). If the burden voltage presents a problem, the percentage error can be calculated using the following formula shown in Figure 6.



E_s = Source voltage

R_L = Load resistance + Source resistance

I_m = Measured current

E_b = Burden voltage (calc.)

$E_b = I_m$ [(200 / current range in mA) + .35] for 2 mA – 2000 mA ranges

$E_b = I_m$ (.015) for 10 A range only

Error in % = 100 x E_b / (E_s – E_b)

Error in A = E_b x I_m / (E_s – E_b)

Example: E_s = 1.7341 V, R_L = 1200 Ω I_m = 1.3336 mA

$E_b = 1.3336 \times 10^{-3} (200/2 + .35) = .1338$

Error in % = 100 x .1338/(1.7341 − .1338)

Error in % = 8.36%

Error in A = .1338 1.3336×10^{-3}/(1.7341 − .1338)

Error in A = 111.5 μA

Add to I_m to get correct current

Figure 6 Burden Voltage Error Calculations

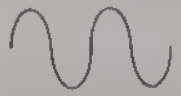
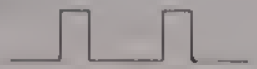
True RMS Measurements

The model 4700 features direct measurement of the RMS or effective value of an ac signal. Mathematically, RMS is defined as the square root of the average of the signal squared over time. In physical terms, the RMS result is equivalent to the dc signal which produces the same heating effect in a resistor as the ac signal. Table 4 is provided to help convert between RMS measurements and average responding RMS calibrated instructions.

To measure a combined ac and dc RMS signal, the following procedure must be used because the model 4700 has a dc blocking capacitor. First, measure and record the dc signal that the ac signal is riding on. Next, measure and record the ac signal. The combined RMS signal may now be calculated using the following formula.

$$\text{Combined RMS Signal} = \sqrt{(\text{dc component})^2 + (\text{ac component})^2}$$

Table 4 Waveform Conversion Factors

Waveforms AC-coupled	Peak Readings		Measured Readings			Comb. RMS
			AC component		DC	
	0-PK	PK-PK	RMS cal	4700	Comp.	Signal
Sine 	1.414	2.828	1.000	1.000	0.000	1.000
Rectified Sine (Full Wave)	1.414	1.414	0.421	0.435	0.900	1.000
Rectified Sine (Half Wave)	2.000	2.000	0.764	0.771	0.636	1.000
Square	2.000	1.000	1.110	1.000	0.000	1.000
Rectified Square	1.414	1.414	0.785	0.707	0.707	1.000
Rectangular Pulse 	2.000	2.000	2.22k	2k	2d	$2\sqrt{d}$
Triangle or Sawtooth	3.464	1.732	0.960	1.000	0.000	1.000

Decibel Measurements

When the dB mode is selected the model 4700 displays subsequent ac or dc voltage measurements as dBm, that is, 0 dB equals 1 mW into 600 ohms. Mathematically, the following formula applies:

$$dBm = 20 \times \log (\text{Voltage input} / .7746\ V)$$

Table 5 is provided for those unaccustomed to thinking in terms of decibels. Note, in the dB mode negative dc voltages are converted to decibel equivalents even though the logarithm of a negative quantity is undefined.

Table 5 Decibel Ratios

dB Change	Ratio Change
20 dB	10:1
10 dB	3.2:1
6 dB	2:1
3 dB	1.4:1
2 dB	1.3:1
1 dB	1.1:1
0 dB	1:1
−1 dB	.9:1
−2 dB	.8:1
−3 dB	.7:1
−6 dB	.5:1
−10 dB	.32:1
−20 dB	.1:1

The model 4700 performs a bridging type measurement. This type of measurement requires that the load impedance be part of the circuit under test. If a terminating measurement must be made the proper load impedance (resistance and power rating) will need to be placed in the circuit under test before the measurement is made.

Decibel measurements can be made with other reference impedences. By using the RELative mode in combination with the dB mode a correction factor may be added or subtracted by the microcomputer to display the dB measurement referenced to a new impedance. To change the reference impedance, select the proper voltage range, apply the 0 dB equivalent voltage for the new reference impedance, and select the RELative mode in combination with the dB mode by pressing SELect. Subsequent measurements are now displayed referenced to the new impedance. Table 6 shows the 0 dB equivalent voltages required to create some of the commonly used reference impedances.

Table 6 Equivalent Voltages for Different Reference Impedances

dBm Reference Impedance Z (Ω)	Equivalent Voltage Level V_L (V)	Equivalent dBm Level dB (dBm)
50	0.2236	−10.79
75	0.2739	−9.03
93	0.3050	−8.10
110	0.3317	−7.37
125	0.3536	−6.81
135	0.3674	−6.48
150	0.3873	−6.02
250	0.5000	−3.80
300	0.5477	−3.01
500	0.7071	−0.79
600	0.7746	0.00
800	0.8944	1.25
900	0.9487	1.76
1000	1.0000	2.22
1200	1.0954	3.01

For dBm impedances not listed above use the following formulas.

$$V_L = \sqrt{.001 \times Z}$$

$$dB = 20 \log \frac{V_L}{.7746}$$

dBW Reference Impedance Z (Ω)	Equivalent Voltage Level V_L (V)	Equivalent dBm Level dB (dBm)
2	1.4142	5.23
4	2.000	8.24
8	2.828	11.25
16	4.000	14.26

For dBW impedances not listed above use the following formulas.

$$V_L = \sqrt{Z}$$

$$dB = 20 \log \frac{V_L}{.7746}$$

Gain Measurements

Gain is usually expressed in decibels. By combining the RELative mode with the dB mode, system gain measurements are greatly simplified because no mental math is necessary. Referring to Figure 7 a gain measurement will be made referenced to TP1.

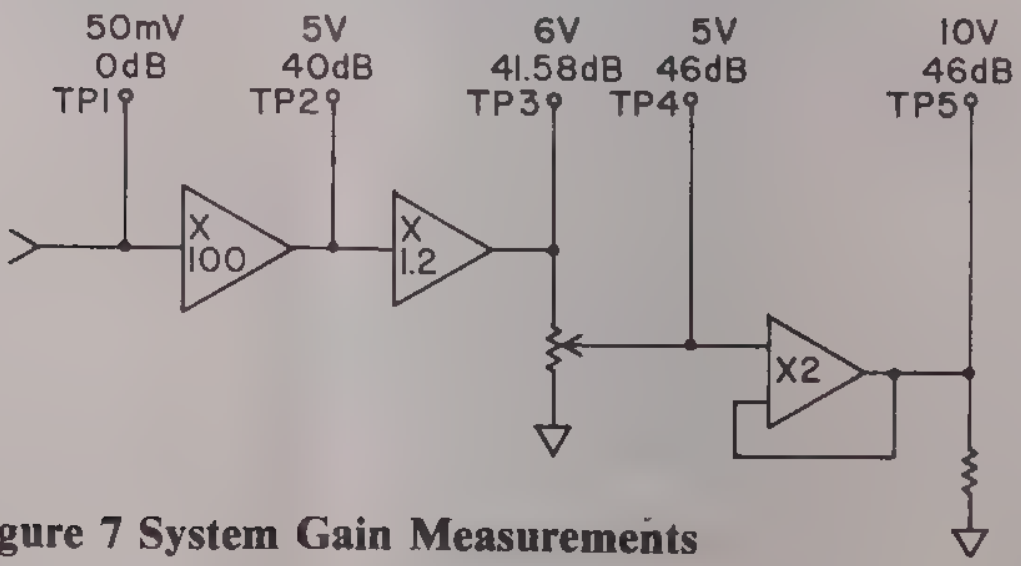


Figure 7 System Gain Measurements

While measuring the voltage at TP1, select the RELative mode in combination with the dB mode. TP1 will now become the 0 dB reference point. The gain or loss in following stages may now be measured.

Accurate Low Resistance Measurements

When measuring resistances of 10 ohms or less, the test lead and fuse resistance can cause an appreciable error. To improve the accuracy, short the test leads and select the RELative mode by pressing SELect. This will subtract the test lead and fuse resistance from the displayed measurement yielding a more accurate measurement of low resistance.

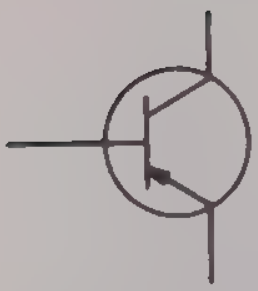
Semiconductor Junction Testing

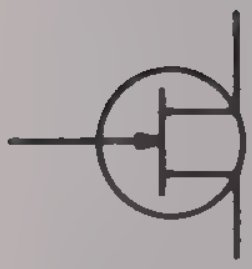
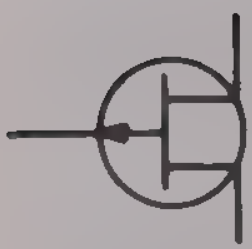
Table 7 gives a variety of uses for the CONTinuity function or high power ohms ranges (2 k, 200 k, and 20 M). Many solid state devices may be given operational tests using the following procedure.

1. Select the CONTinuity function or a high power ohms range shown in Table 7.
2. Insert the test leads, black in the COMmon input terminal and red in the V Ω mA input terminal. The V Ω mA input terminal is positive with respect to the COMmon input terminal.
3. Identify the type of device to be tested and locate this device in Table 7.
4. Connect the test leads to the appropriate points on the device as shown in Table 7.
5. The device may be assumed to be operational if the test yields the results shown in Table 7.

Table 7 Semiconductor Testing

Red Lead = (+)
Black Lead = (−)
NC = No Connection

Device	Range	Lead Conn 1	2	3	Results/ Comments
Diode	2k or CONT	+	−	NC	Overrange
		−	+	NC	Si .5 - .7 Ge .2 - .3
 Transistor PNP	2k or CONT	+	−	NC	Si .5 - .7 Ge. 2 - .3
		−	+	NC	Overrange
		NC	+	−	Overrange
		NC	−	+	Si .5 - .7 Ge .2 - .3
		+	NC	−	Overrange
		−	NC	+	Overrange
Transistor NPN	2k or CONT	+	−	NC	Overrange
		−	+	NC	Si .5 - .7 Ge .2 - .3
		NC	+	−	Si .5 - .7 Ge .2 - .3
		NC	−	+	Overrange
		+	NC	−	Overrange
		−	NC	+	Overrange

 N Channel FET	2k or CONT	+ − NC	Overrange
		− + NC	≈ .6 - .8
		NC + −	≈ .6 - .8
		NC − +	Overrange
		+ NC −	Variable Reading*
		− NC +	Variable Reading*
 P Channel FET	2k or CONT	+ − NC	≈ .6 - .8
		− + NC	Overrange
		NC + −	Overrange
		NC − +	≈ .6 - .8
		+ NC −	Variable Reading*
		− NC +	Variable Reading*
SCR	2k or CONT	+ − +	Overrange
		− + +	≈ .5 - .7 while 3 connected to (+)

*This value depends on device tested.

THEORY OF OPERATION

This section details the theory of operation of the model 4700. CIRCUIT DESCRIPTION provides an overview of the operation of the function blocks that make up the instrument. CIRCUIT OPERATION describes how the function blocks operate together to perform a measurement. A schematic diagram is provided in the insert for further reference.

CIRCUIT DESCRIPTION

The following circuit description refers to the block diagram in Figure 8.

High Energy Fuse

This fuse protects the current shunts from excessive power dissipation. If an overload condition exists the high energy fuse may open.

Voltage Attenuator

When measuring voltage this block scales the input voltage to a level the A/D converter can quantize. Note, the dc blocking capacitor for ac measurements. The voltage attenuator also provides the standard resistors required to form the precision current source for the ohmmeter.

Ohmmeter Current Source

An accurate one volt source is derived from the voltage reference. This is applied across the voltage attenuator resisters to form a precision current source for the resistance and CONTinuity functions.

Ohms Protection

This circuit protects the ohmmeter current source from inadvertant applications of voltage while attempting to make measurements in the resistance or CONTinuity functions.

Current Shunts

The current shunts produce a voltage which is directly proportional to the input current flowing through them.

Current Protection

This along with the high energy fuse protects the current shunts from excessive power dissipation.

10 A Shunt

The 10 A shunt produces a voltage which is directly proportional to the input current flowing through it.

DC Protection

This circuit limits the dc input voltage to the A/D converter.

AC Protection

This circuit limits the ac input voltage to the true RMS converter or the CONTinuity/LOGIC probe comparator depending on the measurement function selected.

True RMS converter

This circuit provides a dc voltage equivalent to the RMS value of the scaled ac input voltage from the voltage attenuator or current shunts.

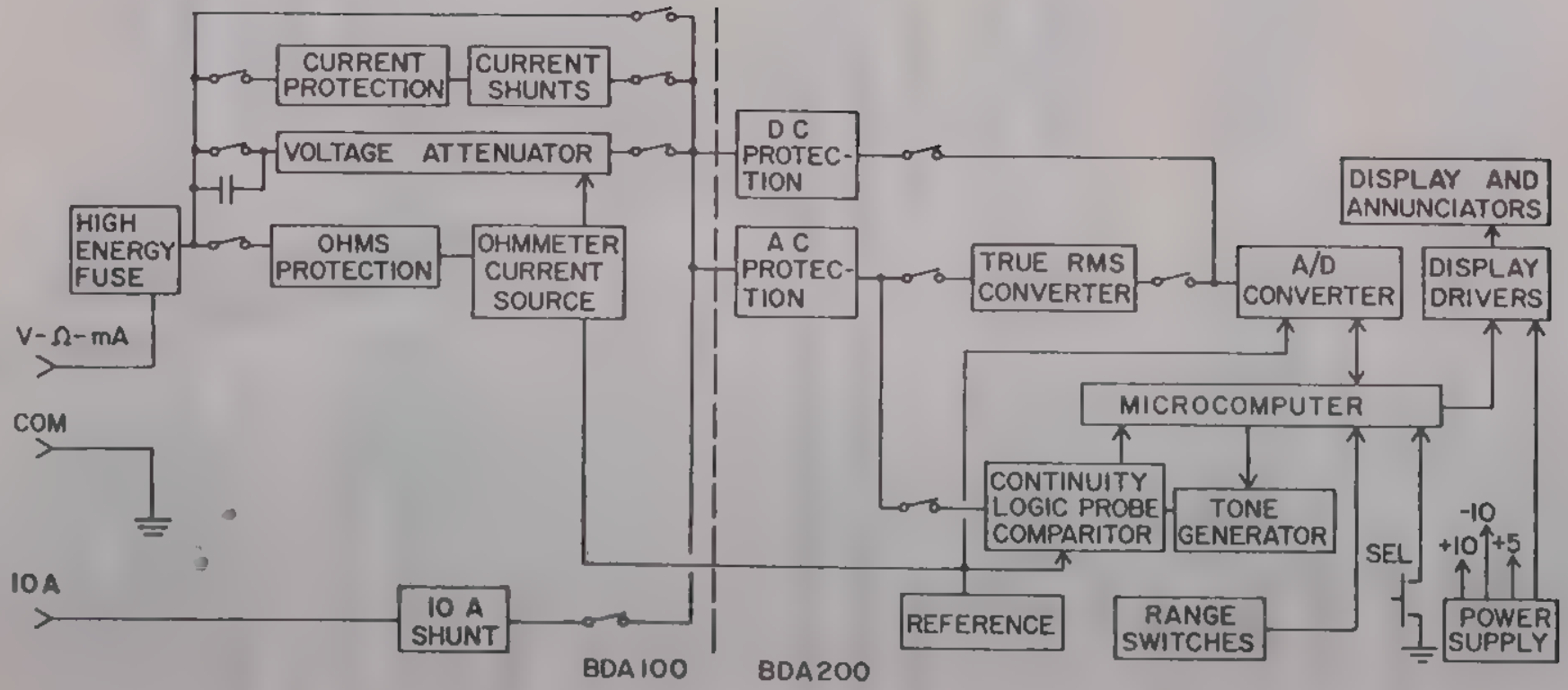


Figure 8 Block Diagram

CONTinuity/LOGIC Probe Comparator

The input signal is compared to one of two threshold voltages set by the reference. In the CONTinuity function the threshold is 200 mV, nominally (i.e. 200 ohms). The LOGIC probe threshold is 1.75 V, nominally.

Tone Generator

The tone generator has two modes of operation. A CONTinuity measurement of less than 200 ohms triggers the tone generator to produce a 500 ms tone. A LOGIC probe measurement uses the microcomputer to control the tone generator if the))) mode is selected.

A/D Converter

This is where the dc voltage from the signal conditioning circuitry is converted to a digital number with the aid of the microcomputer.

Reference

This precision dc voltage source is used by the ohmmeter current source, CONTinuity/LOGIC probe comparator, and the A/D converter to provide a standard to measure against.

Range Switches

The range switches direct the microcomputer and also route signals through the various blocks to perform the selected measurement function.

Microcomputer

The microcomputer performs three functions - control, measurement, and calculation - by receiving inputs from the range switches, CONTinuity/LOGIC probe comparator, A/D converter, and SELect switch. In all functions the microcomputer controls the format of the display, including annunciators and decimal points. If the))) mode is selected in the LOGIC probe function the microcomputer also controls the tone generator. Measurements are made by the microcomputer with the aid of the A/D converter and or the CONTinuity/LOGIC probe comparator. When the RELative mode, the dB mode, or both are selected the microcomputer calculates the offset, the logarithm, or both, respectively.

Display Drivers

The display drivers convert the results from the microcomputer into signals capable of driving the LCD. A signal also comes from the power supply for the LO BAT annunciator.

Display and Annunciators

The LCD shows the result of the selected measurement function along with the proper decimal points and annunciators. The eight annunciators are: HI, LO, OVER, —, LO BAT, dB, REL, and))) .

Power Supply

This block uses a dc to dc converter along with the batteries to generate the necessary dc voltages to power the other function blocks.

CIRCUIT OPERATION

An explanation is given below for the circuit operation of voltage measurements, current measurements, resistance measurements, CONTinuity measurements, and LOGIC probe measurements.

Voltage Measurements

The range switches route the input voltage to the voltage attenuator. If an ac voltage range is selected any dc voltage present is blocked. The scaled input voltage from the voltage attenuator is routed directly to the A/D converter if a dc voltage range is selected. When an ac voltage range is selected the scaled input is routed to the true RMS converter and then to the A/D converter. The A/D converter with the aid of the microcomputer converts the dc signal to a digital value. This value may be used in calculations when the RELative mode or the dB mode is selected or transferred straight to the display drivers with the proper decimal point and annunciator information.

Current Measurements

The range switches or 10 A input terminals route the input current to the current shunts. The current shunts produce a voltage directly proportional to the input current flowing through them. This voltage is routed directly to the A/D converter if a dc current range is selected. When an ac current range is selected the ac voltage analog of the current is routed to the true RMS converter and then to the A/D con-

verter. The A/D converter with the aid of the microcomputer converts the dc signal to a digital value. This value may be used in calculations if the RELative mode is selected or transferred straight to the display drivers with the proper decimal point and annunciator information.

Resistance Measurements

The range switches configure the current source and the voltage attenuator to produce a known dc current at the V Ω mA input terminals. When a resistor is placed across the input terminals a dc voltage analog of the unknown resistance is produced. This voltage is routed to the A/D converter. The A/D converter with the aid of the microcomputer converts the dc voltage to a digital value. This value may be used in calculations if the RELative mode is selected or transferred straight to the display drivers with the proper decimal point and annunciator information.

CONTinuity Measurements

CONTinuity measurements are similar to resistance measurements with the following exceptions. The range switches also route the dc voltage analog of the resistance to the CONTinuity/LOGIC probe comparator. The CONTinuity/LOGIC probe comparator then triggers the tone generator if the value is less than 200 ohms, nominally. The RELative mode cannot be selected in the CONTinuity function.

LOGIC Probe Measurements

The range switches route the input signal directly to the CONTinuity/LOGIC probe comparator. The microcomputer then samples the comparator output. If the))) mode is selected the microcomputer will enable the tone generator on logic edges. The proper annunciators are then transferred to the display drivers.

MAINTENANCE & RECALIBRATION

This section details simple maintenance and calibration procedures. It also includes disassembly and basic troubleshooting information. Any other maintenance or service beyond what is detailed in the following discussion should be performed only by a qualified service technician.

Disassembly and Reassembly

To gain access to the calibration adjustments or the fuse the case bottom must be removed. Any further access to the instrument should be done only by a qualified service technician. If the instrument is disassembled further, the calibration procedure will need to be performed.

To remove the case bottom use the following procedure.

1. Turn the unit off.
2. Disconnect the test leads from any test points and remove the test leads from the input terminals.
3. Remove the two rubber feet at the top back of the unit. They will come out easily by turning them a quarter turn while pulling on them.
4. Loosen the two screws accessed by removing the rubber feet and also loosen the screw at the lower middle of the case bottom. Note, these three screws are captive to the case bottom.

5. Lift off the case bottom and place the ON/OFF switch actuator where it will not get lost.

To replace the case bottom reverse the actions and order of steps 3 through 5, above, making sure to align the ON/OFF switch actuator properly in the case bottom and top.

Fuse Replacement

The model 4700 uses one fuse, a Bussmann fuse type BBS 2 or equivalent. In the event that the fuse needs replacement use the following procedure.

1. Refer to the Disassembly and Reassembly procedure to remove the case bottom.
2. Locate and remove the fuse at the bottom left corner of the unit by loosening the screw holding the fuse clip.
3. Replace the fuse with a Bussmann fuse type BBS 2 or equivalent.
4. Tighten the fuse clip down.

Refer to the Disassembly and Reassembly procedure to replace the case bottom.

Calibration Procedure

The model 4700 is checked and calibrated at the factory. In the event the unit needs calibration use the following procedure. Figure 9 shows the location of the various calibration adjustments.

A ROTEK model 600 or equivalent DMM calibrator and the battery eliminator are required.

1. Allow the model 4700 to stabilize to an ambient temperature of 21 to 25 °C for 30 minutes with the power off.
2. Refer to the Disassembly and Reassembly procedure to remove the case bottom.
3. Turn on the DMM calibrator and power the model 4700 with the battery eliminator allowing a 10 minute warm-up.
4. Select the 2 Vdc range on the model 4700. With a 0 Vdc output from the DMM calibrator, adjust R244 for a display reading of .0000, exactly.
5. Set the DMM calibrator to 1.9000 Vdc. Adjust R240 for a display reading of 1.8999 to 1.9001.
6. Select the 200 mVdc range on the model 4700.
7. Set the DMM calibrator to 190.00 mVdc. Adjust R245 for a display reading of 189.99 to 190.01.
8. Select the 20 kΩ range on the model 4700.
9. Set the DMM calibrator to 10 kΩ. Adjust R114 for a display reading of 9.999 to 10.001.
10. Select the 200 mVac range on the model 4700.
11. Set the DMM calibrator to 10.00 mVac at a frequency of 100 Hz. Adjust R219 for a display reading of 9.99 to 10.01.
12. Set the DMM calibrator to 190.00 mVac at a frequency of 100 Hz. Adjust R214 for a display reading of 189.99 to 190.01.

13. Repeat steps 11 and 12 until both display readings are in the specified limits.
14. Refer to the Disassembly and Reassembly procedure to replace the case bottom.
15. Remove the batteries and continue to power the model 4700 with the battery eliminator.
16. Select the 200 Vac range on the model 4700.
17. Set the DMM calibrator to 100.00 Vac at 10 kHz. Adjust C103 through the access hole in the battery compartment for a display reading of 99.60 to 99.70.
18. Replace the batteries.

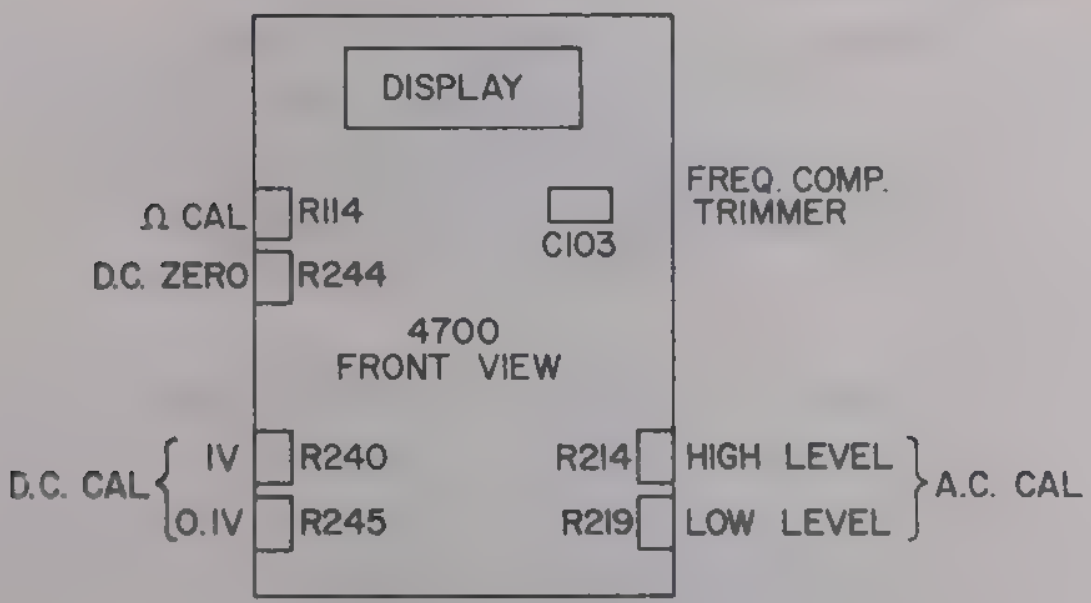


Figure 9 Calibration Adjustment Locations

Basic Troubleshooting

Should the model 4700 fail to function, check the following before assuming there is a defective component.

1. Remove the test leads from any circuit.
2. Turn the model 4700 off and back on. If there is no display or the display is dim check the batteries or use the battery eliminator.
3. Select the resistance function 200 Ω range and short the test leads together. If the display does not come out of overrange check the fuse.
4. If the previous steps do not remedy the problem refer to the section on Service Information.

Service Information

Your model 4700 is warranted for a period of one year from the date of original purchase. For specific details consult the warranty section of this manual. Malfunctions that occur within the limits of the warranty will be corrected at no charge for parts or service.

To register a claim under the provisions of this warranty, return the instrument to Triplett Corporation, Bluffton, OH 45817 or an authorized service center, transportation prepaid. Upon inspection of the instrument, you will be notified of the disposition of your claim.

To expedite repair whether under warranty or not give a detailed description of the problem. This might include such items as the type of measurement made, the range used, and the type of circuit measured.

If the DMM is damaged by an overload and there is evidence of smoke or an electrical arc inside, return the unit to the factory or authorized service center for inspection and repair. There could be some hidden damage that would cause a future failure of the DMM.

ACCESSORIES

The following accessories are available for the model 4700.

Part number	Description
79-516	Miniature clip test leads
10-3126	Leather carrying case
10-3142	Carrying case adapter
10-2961	Vinyl carrying case
10-3127	Plastic carrying case
60-573	Model 10-N Clamp-on ammeter
91-657	0 - 30 Amp External shunt
60-218	Model 101 Line separator
79-496	Model 15 Temperature probe
79-517	6 kV Hi-voltage probe
12472	Battery eliminator

NOTES

LIMITED WARRANTY

The Triplett Corporation warrants instruments and test equipment manufactured by it to be free from defective material or factory workmanship and agrees to repair or replace such products which, under normal use and service disclose the defect to be the fault of our manufacturing, with no charge for parts and service. If we are unable to repair or replace the product, we will make a refund of the purchase price. Consult the Instruction Manual for instructions regarding the proper use and servicing of instruments and test equipment. Our obligation under this warranty is limited to repairing, replacing or making refund on any instrument or test equipment which proves to be defective within one year from the date of original purchase.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons in any way so as, in our sole judgment, to injure their stability or reliability, or which have been subject to misuse, abuse, misapplication, negligence or accident or which have had the serial numbers altered, defaced, or removed. Accessories, including batteries, not of our manufacture used with this product are not covered by this warranty.

To register a claim under the provisions of this warranty, return the instrument or test equipment to

Triplett Corporation, Bluffton, Ohio 45817, transportation prepaid. Upon our inspection of the product, we will advise you as to the disposition of your claim.

ALL WARRANTIES IMPLIED BY LAW ARE HEREBY LIMITED TO A PERIOD OF ONE YEAR, AND THE PROVISIONS OF THE WARRANTY ARE EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES EXPRESSED OR IMPLIED.

The purchaser agrees to assume all liability for any damages and bodily injury which may result from the use or misuse of the product by the purchaser, his employees, or others, and the remedies provided for in this warranty are expressly in lieu of any other liability Triplett Corporation may have, including incidental or consequential damages.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. No representative of Triplett Corporation or any other person is authorized to extend the liability of Triplett Corporation in connection with the sale of its products beyond the terms hereof.

Triplett Corporation reserves the right to discontinue models at any time, or change specifications, price or design, without notice and without incurring any obligation.

This warranty gives you specific legal rights, and you may have other rights which vary from state to state.

TRIPLETT CORPORATION
Bluffton, Ohio 45817

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NOTES

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